USER GUIDE

Trimble BD970
GNSS Receiver Module

Version 5.11
Revision A
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Trimble

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This is the December 2015 release (Revision A) of the BD970 GNSS Receiver Module User Guide. It applies to version 5.11 of the receiver firmware.

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COCOM limits

This notice applies to the BD910, BD920, BD920-W, BD920-W3G, BD930, BD930-UHF, BD935-INS, BD960, BD970, BD982, BX960, BX960-2, and BX982 receivers.
The U.S. Department of Commerce requires that all exportable GPS products contain performance limitations so that they cannot be used in a manner that could threaten the security of the United States. The following limitations are implemented on this product:
– Immediate access to satellite measurements and navigation results is disabled when the receiver velocity is computed to be greater than 1,000 knots, or its altitude is computed to be above 18,000 meters. The receiver GPS subsystem resets until the COCOM situation clears. As a result, all logging and stream configurations stop until the GPS subsystem is cleared.

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Trimble Europe BV
c/o Menlo Worldwide Logistics
Meerheide 45
5521 DZ Eersel, NL

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CHAPTER 1

Introduction

- About the BD970 GNSS receiver
- BD970 features
- Default settings
- Technical support

This manual describes how to set up, configure, and use the Trimble® BD970 GNSS receiver module. The BD970 receiver uses advanced navigation architecture to achieve real-time centimeter accuracies with minimal latencies.

Even if you have used other GNSS or GPS products before, Trimble recommends that you spend some time reading this manual to learn about the special features of this product. If you are not familiar with GNSS or GPS, visit the Trimble website (www.trimble.com).

About the BD970 GNSS receiver

This receiver is used for a wide range of precise positioning and navigation applications. These uses include unmanned vehicles and port and terminal equipment automation, and any other application requiring reliable, centimeter-level positioning at a high update rate and low latency.

The receiver offers centimeter-level accuracy based on carrier phase RTK and submeter accuracy code-based solutions.

Automatic initialization and switching between positioning modes allow for the best position solutions possible. Low latency (less than 20 ms) and high update rates give the response time and accuracy required for precise dynamic applications.

The receiver can be configured as an autonomous base station (sometimes called a reference station) or as a rover receiver (sometimes called a mobile receiver). Streamed outputs from the receiver provide detailed information, including the time, position, heading, quality assurance (figure of merit) numbers, and the number of tracked satellites. The receiver also outputs a one pulse-per-second (1 PPS) strobe signal which lets remote devices precisely synchronize time.

Designed for reliable operation in all environments, the receiver provides a positioning interface to an office computer, external processing device, or control system. The receiver can be controlled through a serial, ethernet, USB, or CAN port using binary interface commands or the web interface.

BD970 features

The receiver has the following features:

- 220 Channels:
  - GPS: Simultaneous L1 C/A, L2E, L2C, L5
  - GLONASS: Simultaneous L1 C/A, L1 P, L2 C/A (GLONASS M Only), L2 P
  - SBAS: Simultaneous L1 C/A, L5
  - GALILEO: Simultaneous L1 BOC, E5A, E5B, E5AltBOC
  - BeiDou: Simultaneous B1, B2
  - QZSS: Simultaneous L1 C/A, L1 SAIF, L2C, L5
- Advanced Trimble Maxwell Custom Survey GNSS Technology
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Proven Trimble low elevation tracking technology
- 1 USB port
- 1 CAN port
- 1 LAN Ethernet port
- Network Protocols supported
  - HTTP (web interface)
  - NTP Server
  - NMEA, GSOF, CMR over TCP/IP or UDP
  - NTripCaster, NTripServer, NTripClient
  - mDNS/UPnP Service discovery
  - Dynamic DNS
  - Email alerts
  - Network link to Google Earth
  - Support for external modems via PPP
- 3 x RS232 ports (baud rates up to 460,800)
- 1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 & 50 Hz positioning outputs (depending on the installed option)
- Up to 50 Hz raw measurement and position outputs
- Correction inputs/outputs: CMR, CMR+™, sCMRx, RTCM 2.1, 2.2, 2.3, 2.4, 3.X, 3.2.
  Note:

  - The functionality to input or output any of these corrections depends on the installed options.
  - Different manufacturers may have established different packet structures for their correction messages. Thus, the BD9xx receivers may not receive corrections from other manufacturers' receivers, and other manufacturers' receivers may not be able to receive corrections from BD9xx receivers.
- Navigation outputs:
  - ASCII: NMEA-0183: GBS; GGA; GLL; GNS; GRS; GSA; GST; GSV; HDT; LLQ; PTNL,AVR; PTNL,BPQ; PFUGDP; DTM; PTNL,GGK; PTNL,PJK; PTNL,PJT; PTNL,VGK; PTNL,VHD; RMC; ROT; VTG; ZDA
  - Binary: Trimble GSOF
- Control Software
- 1 pulse-per-second (1PPS) output
- Event Marker Input support
- LED drive support

Default settings

All settings are stored in application files. The default application file, Default.cfg, is stored permanently in the receiver, and contains the factory default settings. Whenever the receiver is reset to its factory defaults, the current settings (stored in the current application file, Current.cfg) are reset to the values in the default application file.

These settings are defined in the default application file.

Function	Settings	Factory default
SV Enable	-	All SVs enabled
General Controls	Elevation mask	10°
	PDOP mask	99
	RTK positioning mode	Low Latency
	Motion	Kinematic
Ports	Baud rate	38,400
	Format	8-None-1
	Flow control	None
Input Setup	Station	Any
NMEA/ASCII (all supported messages)		All ports Off
Streamed Output		All types Off
		Offset=00
RT17/Binary		All ports Off
Reference Position	Latitude	0°
	Longitude	0°
	Altitude	0.00 m HAE
Antenna	Type	Unknown
	Height (true vertical)	0.00 m
	Measurement method	Antenna Phase Center
1PPS		Disabled

If a factory reset is performed, the above defaults are applied to the receiver. The receiver also returns to a DHCP mode, and security is enabled (with a default login of **admin** and the password of **password**). To perform a factory reset:

- From the web interface, select *Receiver Configuration* / *Reset* and then clear the *Clear All Receiver Settings* option.
- Send the Command 58h with a 03h reset value.

Technical support

If you have a problem and cannot find the information you need in the product documentation, send an email to GNSSOEMSupport@trimble.com.

Documentation, firmware, and software updates are available at: www.intech.trimble.com/support/oem_gnss/receivers/trimble.

CHAPTER 2

Specifications

- Performance specifications
- Physical specifications
- Electrical specifications
- Environmental specifications
- Communication specifications
- Receiver drawings

This chapter details the specifications for the receiver.

Specifications are subject to change without notice.

Performance specifications

Feature	Specification

Measurements	• Position antenna based on a 220-channel Maxwell 6 chip:
	  ◦ GPS: Simultaneous L1 C/A, L2E, L2C, L5
	  ◦ GLONASS: Simultaneous L1 C/A, L1 P, L2 C/A (GLONASS M Only), L2 P
	  ◦ SBAS: Simultaneous L1 C/A, L5
	  ◦ GALILEO: Simultaneous L1 BOC, E5A, E5B, E5AltBOC
	  ◦ BeiDou: Simultaneous B1, B2
	  ◦ QZSS: Simultaneous L1 C/A, L1 SAIF, L2C, L5
	• Advanced Trimble Maxwell 6 Custom Survey GNSS Technology
	• High precision multiple correlator for GNSS pseudorange measurements
	• Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
	• Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
	• Signal-to-Noise ratios reported in dB-Hz
	• Proven Trimble low elevation tracking technology

Code differential GPS positioning accuracy[1]	3D: Typically, < 1 m
SBAS accuracy[2]	Horizontal: Typically, < 1 m Vertical: Typically, < 5 m
RTK positioning accuracy (<30 km)	Horizontal: ±(8 mm + 1 ppm) RMS Vertical: ±(15 mm + 1 ppm) RMS
Initialization time	Typically, less than 10 seconds

[1]Accuracy and reliability may be subject to anomalies such as multipath, obstructions, satellite geometry, and atmospheric conditions. Always follow recommended practices.

[2]Depends on WAAS, EGNOS, and MSAS system performance.

Feature	Specification
Initialization reliability[1]	Typically >99.9%

Physical specifications

Feature	Specification
Dimensions (L x W x H)	100 mm x 60 mm x 11.6 mm
Vibration	MIL810F, tailored Random 6.2 gRMS operating Random 8 gRMS survival
Mechanical shock	MIL810D ±40 g operating ±75 g survival
I/O connector	24-pin header + 6-pin header (Samtec TMM-120-03-L-D) (Rated for 1000 cycles)
Antenna connector	MMCX receptacle (Huber-Suhner 82MMCX-50-0-1/111) (Rated for 500 cycles); mating connectors are MMCX plug (Suhner 11MMCX-50-2-1C) or right-angle plug (Suhner 16MMCX-50-2-1C, or 16MMCX-50-2-10)

Electrical specifications

Feature	Specification
Voltage	3.3 V DC +5%/-3%
Power consumption	Typically, 1.45 W (L1/L2 GPS) Typically, 1.55 W (L1/L2 GPS and G1/G2 GLONASS) Typically, 2.35 W (L1/L2/L5 GPS, G1/G2 GLONASS, B1/B2 BeiDou, L1/E5 Galileo) ***Note*** *– These values were characterized using v4.84 firmware.*
Minimum required LNA gain	32.5 dB ***Note*** *– This receiver is designed to operate with the Zephyr Model 2 antenna which has a gain of 50 dB. Higher-gain antennas have not been tested.*

[1] May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.

Environmental specifications

Feature	Specification
Temperature	Operating: -40°C to 75°C (-40°F to 167°F)
	Storage: -55°C to 85°C (-67°F to 185°F)
Vibration	MIL810F, tailored Random 6.2 gRMS operating Random 8 gRMS survival
Mechanical shock	MIL810D +/- 40 g operating +/- 75 g survival
Operating humidity	5% to 95% R.H. non-condensing, at +60°C (140°F)

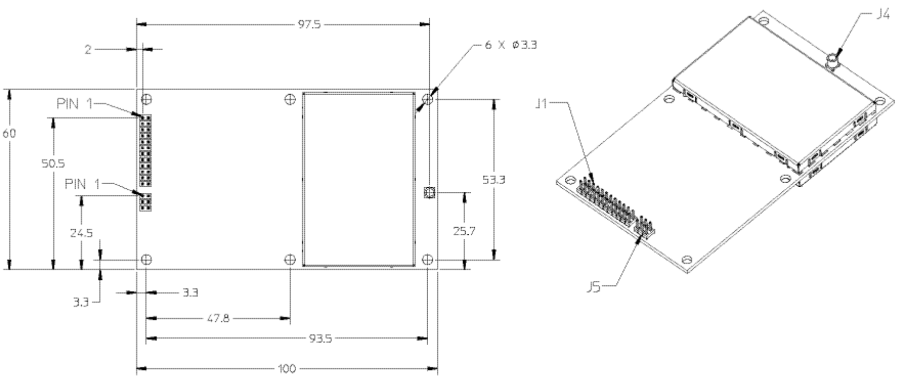
Communication specifications

Feature	Specification	
Communications	1 LAN port	• Supports links to 10BaseT/100BaseT networks. • All functions are performed through a single IP address simultaneously – including web interface access and data streaming.
	3 x RS-232 ports	Baud rates up to 460,800
	1 USB 2.0 port	
Receiver position update rate	1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz and 50 Hz positioning	
Correction data input	CMR, CMR+™, sCMRx, RTCM 2.0–2.4, RTCM 3.X, 3.2	
Correction data output	CMR, CMR+, sCMRx, RTCM 2.0 DGPS (select RTCM 2.1), RTCM 2.1–2.4, RTCM 3.X, 3.2	
Data outputs	1PPS, NMEA, Binary GSOF, ASCII Time Tags	

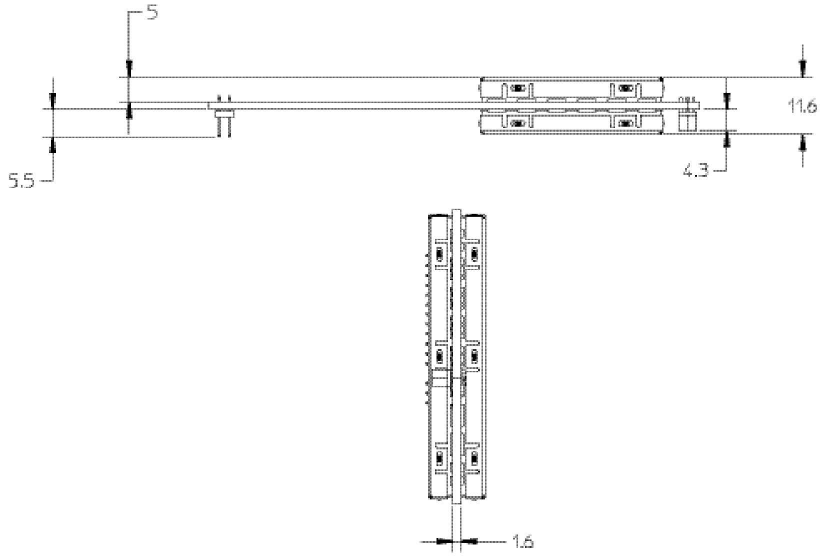
Receiver drawings

The following drawings show the dimensions of the BD970 receiver. Refer to these drawings if you need to build mounting brackets and housings for the receiver.

Plan view



Edge view



CHAPTER 3

Electrical System Integration

- BD970 receiver pinouts
- 1PPS and ASCII time tag
- ASCII time tag
- Power input
- Antenna power output
- LED control lines
- Power switch and reset
- Event
- Serial port
- USB
- Ethernet
- CAN

BD970 receiver pinouts

The receiver has a 24-pin and a 6-pin header side-by-side.

24-pin header

Pin	Signal name	Description	Integration notes
1	GND	Ground Digital ground	Ground Digital ground
2	RTK LED	RTK LED. Flashes when an RTK correction is present. This is similar to all BD9xx products, except for the requirement for an external resistor.	When used to drive an LED, a series resistor with a typical value of 300 Ohms is required. This pin supplies a maximum current of 4mA For LEDs with Vf above 2.7 or current excess of 4mA, an external buffer is required.
3	POWER_ OFF	Powers the unit on and off.	Drive high with a 3.3 V to turn off, leave floating or ground to keep the unit on. Integrators should not drive TTL signals when the unit is not powered.
4	PPS (Pulse Per Second)	Pulse Per Second	This is 3.3 V TTL level, 4mA max drive capability. To drive 50 load to ground, an external buffer is required.
5	VCC Input DC Card Power	VCC Input DC Card power (3.3 V only)	VCC Input DC Card power (3.3 V only)
6	VCC Input DC Card Power	VCC Input DC Card power (3.3 V only)	VCC Input DC Card power (3.3 V only)
7	Event2, CAN1_Rx and COM3_ Rx	Event2 – Event input CAN1_Rx - CAN Receive line COM3_Rx – COM3 Receive line – TTL Level	MUTUALLY EXCLUSIVE and TTL level. Connect Event2 to a TTL level signal to use as Event. Connect CAN1_Rx to RX line of a CAN driver to use as CAN.

Pin	Signal name	Description	Integration notes
			Connect COM3_Rx to a transceiver if RS-232 level is required.
8	Event1	Event1 – Input	Event1 (must be 3.3 V TTL level)
9	Power LED	POWER Indicator. High when unit is on, low when off. This is similar to all BD9xx products, except for the requirement for an external resistor. This allows user to use this as a control line.	When used to drive an LED, a series resistor with a typical value of 300 Ohms is required. This pin supplies a maximum current of 4mA For LEDs with Vf above 2.7 or current excess of 4mA, an external buffer is required.
10	Satellite LED	Satellite LED. Rapid flash indicates <5 satellites. Slow flash indicates >5 satellites.	When used to drive an LED, a series resistor with a typical value of 300 Ohms is required. This pin supplies a maximum current of 4mA For LEDs with Vf above 2.7 or current excess of 4mA, an external buffer is required.
11	COM2_CTS	COM2 Clear to Send – TTL Level	Connect COM2_CTS to a transceiver if RS-232 level is required.
12	RESET_IN	RESET_IN – ground to reset	Drive low to reset the unit. Otherwise, leave unconnected.
13	COM2_RTS	COM 2 Request to Send – TTL Level	Request to Send for COM 2 connect to a transceiver if RS-232 level is required.
14	COM2_Rx	COM 2 Receive Data – TTL Level	Connect COM2_RX to a transceiver if RS-232 level is required.
15	NO CONNECT	Reserved	
16	COM2_Tx	COM 2 Transmit Data – TTL Level	Connect COM2_TX to a transceiver if RS-232 level is required
17	NO CONNECT	Reserved	
18	COM1_Rx	COM 1 Receive Data – RS-232 Level	
19	CAN1_Tx and COM3_Tx	CAN1_Tx - CAN Transmit line COM3_Transmit Data – TTL Level	MUTUALLY EXCLUSIVE and TTL level. Connect CAN1_Tx to TX line of a CAN driver to use as CAN.

Pin	Signal name	Description	Integration notes
			Connect COM3_Tx to a transceiver if RS-232 level is required
20	COM1_Tx	COM 1 Transmit Data – RS-232 Level	
21	USB D (-)	USB D (-) Bi-directional USB interface data (-)	Device Mode only. If VCC is supplied, USB detects VBUS.
22	USB D (+)	USB D (+) Bi-directional USB interface data (+)	Device Mode only. If VCC is supplied, USB detects VBUS.
23	GND	Ground Digital ground	Ground Digital ground
24	GND	Ground Digital ground	Ground Digital ground

6-pin header

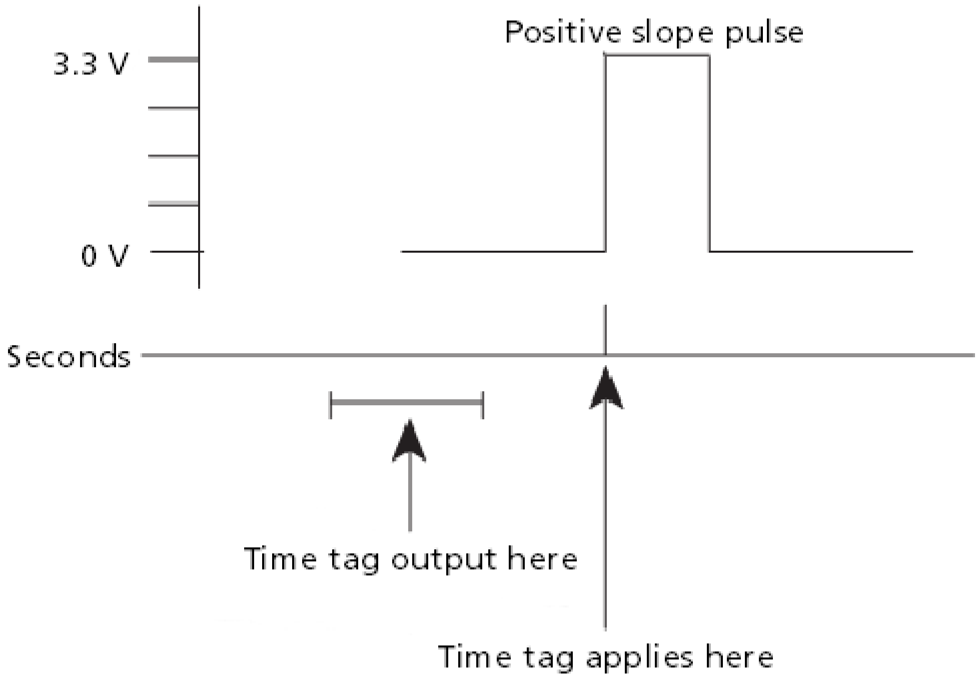
Pin	Signal name	Description	Integration notes
1	ETH_RD-	Ethernet Receive line minus. Differential pair.	Connect to Magnetics RD-.
2	ETH_RD+	Ethernet Receive line plus. Differential pair.	Connect to Magnetics RD+.
3	CENT_RD	RD Magnetic center tap.	Connect to Magnetics RD Center Tap.
4	ETH_TD+	Ethernet Transmit line plus. Differential pair.	Connect to Magnetics TD+.
5	ETH_TD-	Ethernet Transmit line minus. Differential pair.	Connect to Magnetics TD-.
6	CENT_TD	TD Magnetic center tap.	Connect to Magnetics TD Center Tap.

1PPS and ASCII time tag

The receiver can output a 1 pulse-per-second (1PPS) time strobe and an associated time tag message. The time tags are output on a user-selected port.

The leading edge of the pulse coincides with the beginning of each UTC second. The pulse is driven between nominal levels of 0.0 V and 3.3 V (see below). The leading edge is positive (rising from 0 V to 3.3 V). The receiver PPS out is a 3.3 V TTL level with a maximum source/sink current of 4 mA. If the system requires a voltage level or current source/sink level beyond these levels, you must have an external buffer. This line has ESD protection.

The illustration below shows the time tag relation to 1PPS wave form:



The pulse is about 8 microseconds wide, with rise and fall times of about 100 ns. Resolution is approximately 40 ns, where the 40 ns resolution means that the PPS shifting mechanism in the receiver can align the PPS to UTC/GPS time only within +/- 20 ns, but the following external factor limits accuracy to approximately ±1 microsecond:

- Antenna cable length

  Each meter of cable adds a delay of about 2 ns to satellite signals, and a corresponding delay in the 1PPS pulse.

ASCII time tag

Each time tag is output about 0.5 second before the corresponding pulse. Time tags are in ASCII format on a user-selected serial port. The format of a time tag is:

UTC yy.mm.dd hh:mm:ss ab

Where:

- UTC is fixed text.
- *yy.mm.dd* is the year, month, and date.
- *hh:mm:ss* is the hour (on a 24-hour clock), minute, and second. The time is in UTC, not GPS.
- *a* is an integer number representing the position-fix type:

  1 = time solution only

  2 = 1D position and time solution

  3 = currently unused

  4 = 2D position and time solution

  5 = 3D position and time solution
- *b* is the number of GNSS satellites being tracked. If the receiver is tracking 9 or more satellites, b will always be displayed as 9.
- Each time tag is terminated by a *carriage return*, *line feed* sequence. A typical printout looks like:

  UTC 02.12.21 20:21:16 56

  UTC 02.12.21 20:21:17 56

  UTC 02.12.21 20:21:18 56

Note *– If the receiver is not tracking satellites, the time tag is based on the receiver clock. In this case, a and b are represented by "??". The time readings from the receiver clock are less accurate than time readings determined from the satellite signals.*

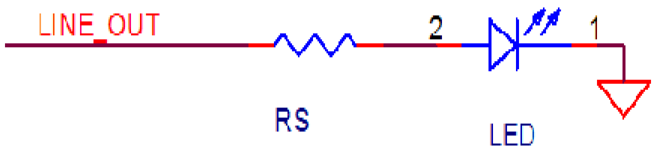
Power input

Item	Description
Power requirement	The unit operates at 3.3 V +5%/-3%. The 3.3 V should be able to supply 1 A of surge current. Worst-case full load power consumption including antenna is 2.5 W. The typical power consumption based on band usage is: • Enable GPS only L1/L2/L5 = 1.6 W • GPS + GLONASS = 1.7 W • All bands enabled = 1.75 W
Power switch	Pin 3 is an optional power-off pin. When driven high with 3.3V, the receiver is powered off. This unit can be left floating or ground to keep the unit on. System integrators should not drive TTL signals when unit is not powered..
Over-voltage protection	The absolute maximum voltage is 3.6 V.
Under-voltage protection	The absolute minimum voltage is 3.2 V below nominal.
Reverse voltage protection	The unit is protected down to -3.6 V.

Antenna power output

Item	Description
Power output specification	The antenna supplies 100 mA at 5 V.
Short-circuit protection	The unit has an over-current / short circuit protection. Short circuits may cause the unit to reset.

LED control lines

Item	Description
Driving LEDs	The outputs are 3.3V TTL level with a maximum source/sink current of 4mA. An external series resistor must be used to limit the current. The value of the series resistor in Ohms is determined by: (3.3-Vf)/(If) > Rs > (3.3 V - Vf)/(.004) Rs = Series resistor If = LED forward current, max typical If of the LED should be less than 3mA Vf = LED forward voltage, max typical Vf of the LED should be less than 2.7V Most LEDs can be driven directly as shown in the circuit below:  LEDs that do not meet If and Vf specification must be driven with a buffer to ensure proper voltage level and source/sink current.
Power LED	This active-high line indicates that the unit is powered on.
Satellite LED	This active-high line indicates that the unit has acquired satellites. A rapid flash indicates that the unit has less than 5 satellites acquired while a slow flash indicates greater than 5 satellites acquired. This line will stay on if the unit is in monitor mode.
RTK Correction	A slow flash indicates that the unit is receiving corrections. This will also flash when the unit is in monitor mode.

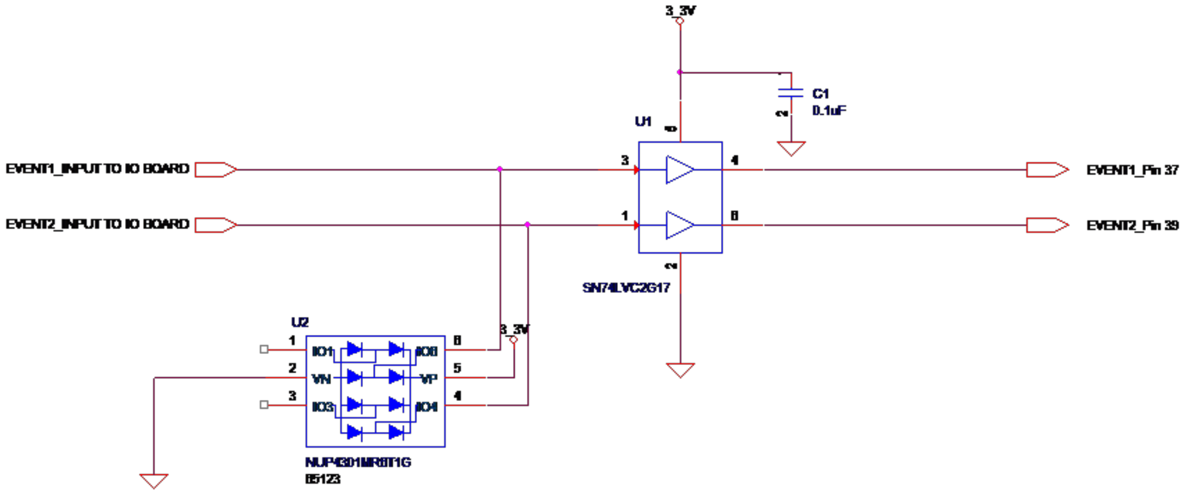
Power switch and reset

Item	Description
Power switch	The integrator may choose to power on or power off the unit. If a 3.3 V level signal is applied to pin 3, Power_Off pin, the unit will disconnect VCC. The system integrator must ensure that other TTL level pins remain unpowered when Power_Off is asserted. Powering TTL-level pins while the unit is powered off will cause excessive leakage current to be sinked by the unit. The integrator may choose to always have the unit powered on. This is accomplished by leaving the Power_Off pin floating or grounded.
Reset switch	Driving Reset_IN_L, Pin 12, low will cause the unit to reset. The unit will remain reset at least 140 mS after the Reset_In_L is deasserted. The unit remains powered while in reset.

Event

Item	Description
Event 1	Pin 8 is dedicated as an Event_In pin. This is a TTL only input; it is not buffered or protected for any inputs outside of 0 V to 3.3 V. It does have ESD protection. If the system requires event to handle a voltage outside this range, the system integrator must condition the signal prior to connecting to the unit.
Event 2	Event 2 is multiplexed with COM3_RX and CAN_RX. The default setting is to have this line set to COM3_RX. The Event 2 must be enabled in order to use Event2. When using the 63494 Development interface board, the user must not connect anything to Port 3 and the CAN port when using Event 2. The Com3 level selection switch is ignored when Event 2 is selected. This is a TTL only input; it is not buffered or protected for any inputs outside of 0 V to 3.3 V. It does have ESD protection. If the system requires event to handle a voltage outside this range, the system integrator must condition the signal prior to connecting to the unit.

Trimble recommends adding a Schmitt trigger and ESD protection to the Event_In pin. This prevents any 'ringing' on the input from causing multiple and incorrect events to be recognized.



For more information, go to www.trimble.com/OEM_ReceiverHelp/V5.11/default.html#AppNote_ EventInput.html.

Serial port

Item	Description
COM 1 RS-232 level no flow control	COM 1 is already at RS-232 level and already has 8 kV contact discharge/15 kV air gap discharge ESD Protection. This is labeled Port 1 on the I/O board.
COM 2 TTL level with flow control	COM 2 is at 0-3.3 V TTL. This port has RTS/CTS to support hardware flow control. If the integrator needs this port to be at RS-232 level, a proper transceiver powered by the same 3.3V that powers the receiver needs to be added. For development using the I/O board, this COM port is already connected to an RS-232 transceiver. This is labeled Port 2 on the I/O board.
COM 3 TTL level no flow control	COM 3 is at 0-3.3 V TTL and is multiplexed with CAN. The receive line is also multiplexed with Event 2. The integrator must have a BD982 receiver configured to use the serial port in order to use this port as a serial port. The functionality cannot be multiplexed in real time. If the integrator needs this port to be at RS-232 level, a proper transceiver powered by the same 3.3 V that powers the receiver needs to be added. For development using the I/O board, this com port is already connected to an RS-232 transceiver. This is labeled Port 3 on the I/O board. SW4, labeled COM3 HW Xciever Selection, must be set to RS-232. There should not be anything connected to TP5, labeled Event 2.

USB

The USB has a built-in PHY. The unit supports USB 2.0 Device configuration at low speed, full speed and high speed configuration. The port has ESD protection; however a USB 2.0 compliant common mode choke located near the connector should be added to ensure EMI compliance.

Ethernet

The receiver contains the Ethernet MAC and PHY, but requires external magnetics. The PHY layer is based on the Micrel KSZ8041NLI it is set to default to 100Mbps, full duplex with auto-negotiation enabled. The receiver has the proper PHY termination on the differential signals as well as Bulk capacitance for the magnetics center tap.

Isolation transformer selection

Parameters	Value	Test condition
Turns Ratio	1CT:1CT	
Open-circuit inductance (min.)	350 uH	100 mV, 100 kHz, 8 mA
Leakage inductance (max.)	0.4 uH	1 MHz (min.)
DC resistance (max.)	0.9 Ohms	
Insertion loss (max.)	1.0 dB	0 MHz–65 MHz
HiPot (min.	1500 Vrms	

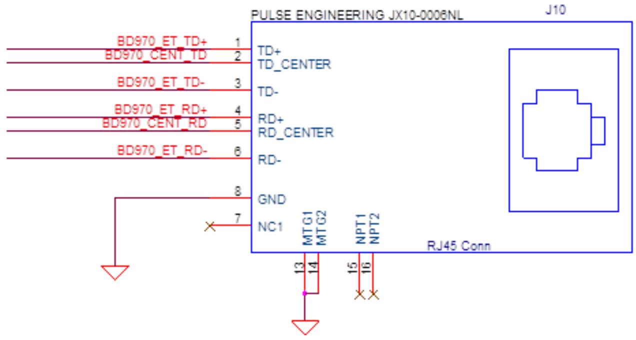
Ethernet reference design

The Ethernet interface can be implemented using a single part or using discrete components. For more information, see:

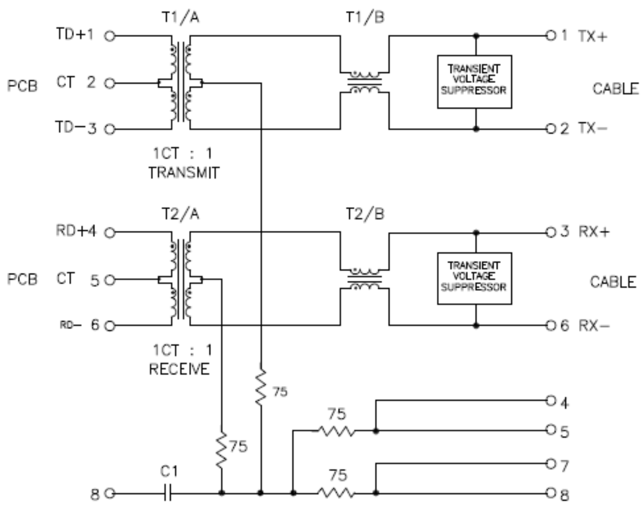
- Ethernet design using RJ-45 with integrated magnetics, page 28
- Ethernet design using discrete components, page 29

Ethernet design using RJ-45 with integrated magnetics

The Ethernet interface can be implemented with a single part by using an integrated part like TE Connectivity's 6605767-1 which has magnetics, common mode choke, termination and transient voltage suppression fully integrated in one part.



RJ-45 drawing



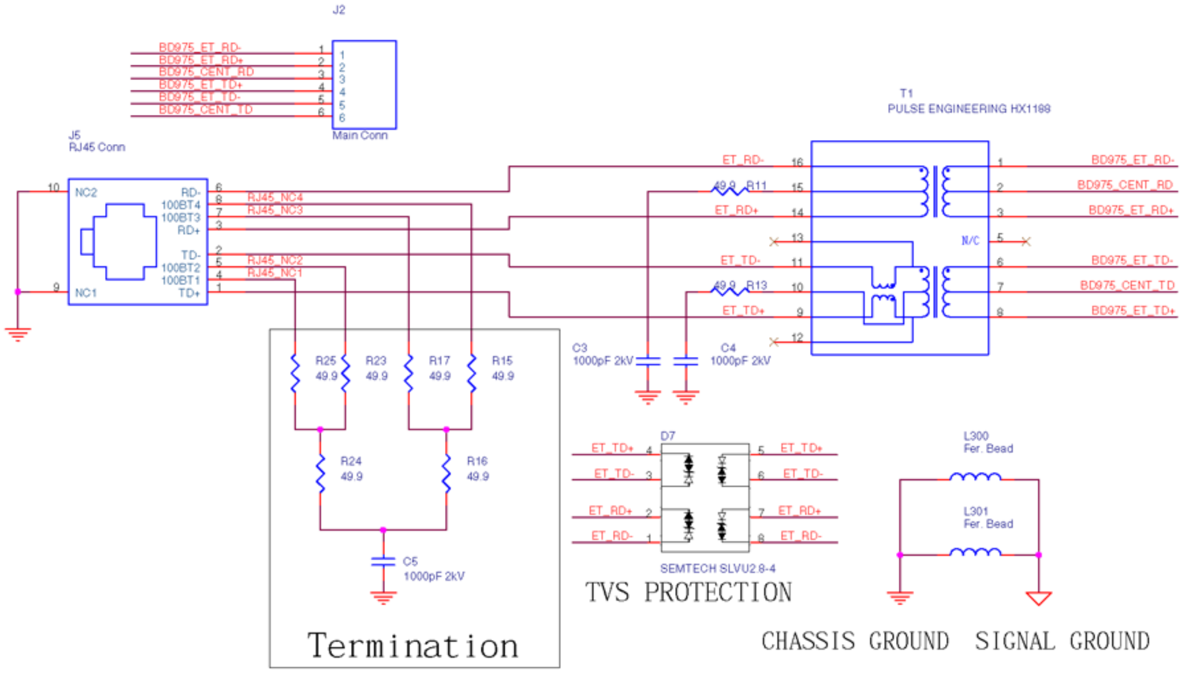
JX10-0006NL schematic

Electrical characteristics

Parameter	Specifications	
Insertion loss	100 kHz	1-125 MHz
	-1.2 dB max.	$-0.2–0.002*f^{1.4}$ db max.
Return loss (Z out = 100 Ohm +/- 15%)	0.1–30 MHz: 30–60 MHz: 60–80 MHz:	-16 dB min. $-10+20*LOG_{10}$ (f/60 MHz dB min.) -10 dB min.
Inductance (OCL) (Media side -40°C + 85°C)	350 uH min.	Measured at 100 kHz, 100 mVRMS and with 8 mA DC bias)
Crosstalk, adjacent channels	1 MHz	10-100 MHz
	-50 dB min.	$-50+17*LOG_{10}$(f/10) dB min.
Common mode rejection radio	2 MHz	30–200 MHz
	-50 dB min.	$-15+20*LOG_{10}$ (f/200) dB min.
DC resistance 1/2 winding	0.6 Ohms max.	
DC resistance imbalance	+/- 0.065 Ohms max. (center tap symmetry)	
input - output isolation	1500 Vrms min. at 60 seconds	

Ethernet design using discrete components

For maximum flexibility, a system integrator may choose to implement the Ethernet using discrete parts. The design below shows an example of such a design. It includes the Ethernet magnetics, termination of unused lines as well as surge protection. The magnetics used is a Pulse Engineering HX1188. Surge protection is provided by a Semtech SLVU2.8-4. In order to meet electrical isolation requirements, it is recommended to use capacitors with a greater than 2 kV breakdown voltage.



Ethernet schematic

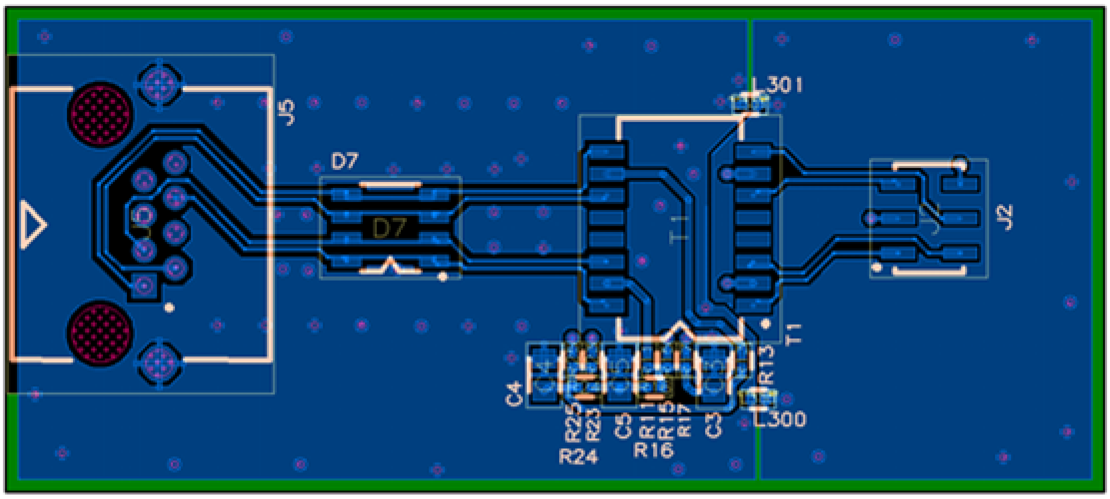
Part Reference	Value
C3	1000pF 2 kV
C4	1000pF 2 kV
C5	1000pF 2 kV
D7	SEMTECH SLVU2.8–4
J2	Main Conn
J5	RJ45 Conn
L300	Fer. Bead 300 mA 1 k @ 1 MHz
L301	Fer. Bead 300 mA 1 k @ 1 MHz
R11	49.9 0402 1%
R13	49.9 0402 1%
R15	49.9 0402 1%
R16	49.9 0402 1%
R17	49.9 0402 1%

Part Reference	Value
R23	49.9 0402 1%
R24	49.9 0402 1%
R25	49.9 0402 1%
T1	Pulse engineering HX1188

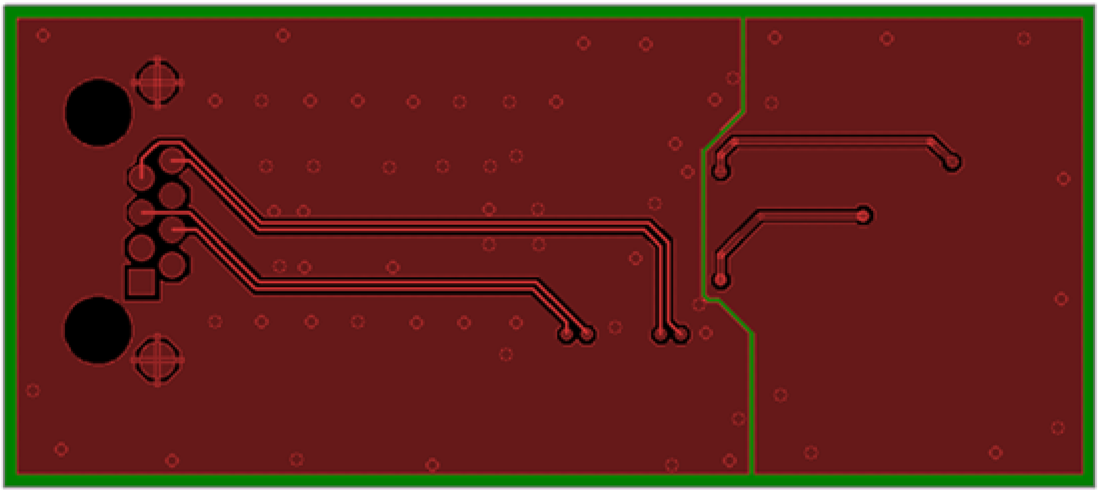
Ethernet routing

The distance from J11, the Ethernet connector and the magnetics should be less than 2 inches. The distance from the RJ-45 and the magnetics should be minimized to prevent conducted emissions issues. In this design, the chassis ground and signal ground are separated to improve radiated emissions. The integrator may choose to combine the ground. The application note from the IC vendor is provided below for more detailed routing guidelines.

The sample routing below shows a two-layer stack up, with single side board placement. The routing shown below makes sure that the differential pairs are routed over solid planes.



Top view



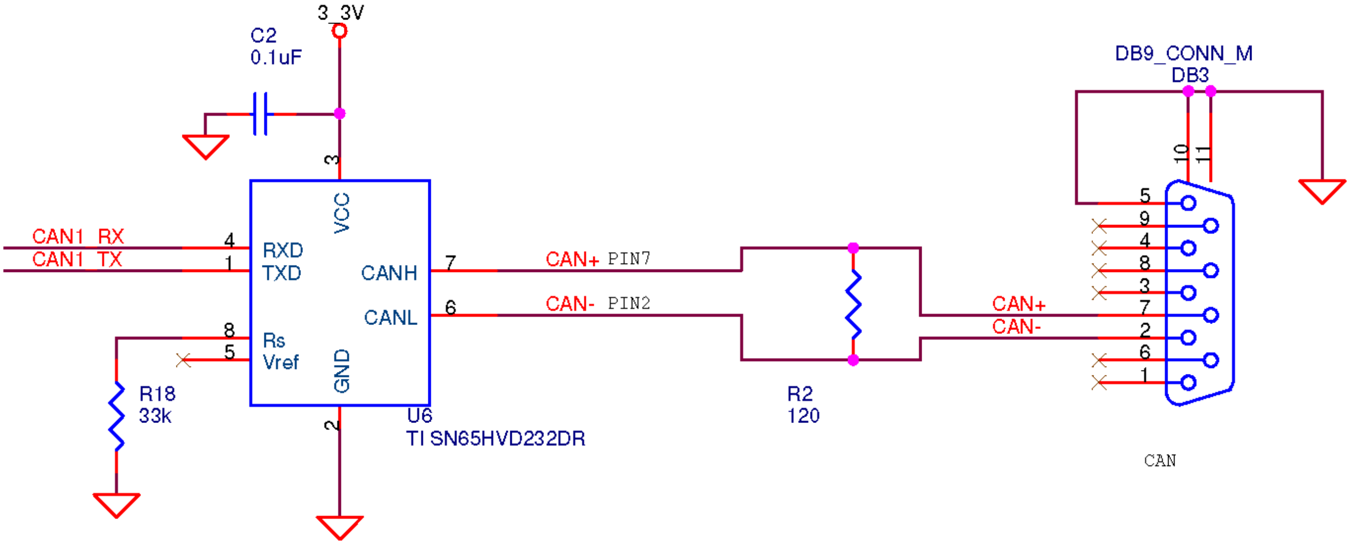
Bottom view

CAN

COM 3 is at 0-3.3 V TTL and is multiplexed with CAN. The receive line is also multiplexed with Event 2. The integrator must have a receiver configured to use the CAN port in order to use this port as a serial port. The functionality cannot be multiplexed in real time. The integrator must add a CAN transceiver in order to use the CAN Port.

For development using the I/O board, this com port is already connected to a CAN transceiver. This is labeled CAN on the I/O board. SW4, labeled COM3 HW Xciever Selection, must be set to CAN. There shouldn't be anything connected to TP5, labeled Event 2.

The following figure shows a typical implementation with a 3.3 V CAN transceiver. It also shows a common mode choke as well as ESD protection. A 5 V CAN Transceiver can be used if proper level translation is added.



CHAPTER 4

Installation

- Unpacking and inspecting the shipment
- Installation guidelines
- Interface board evaluation kit
- Routing and connecting the antenna cable
- LED functionality and operation

Unpacking and inspecting the shipment

Visually inspect the shipping cartons for any signs of damage or mishandling before unpacking the receiver. Immediately report any damage to the shipping carrier.

Shipment carton contents

The shipment will include one or more cartons depending on the number of optional accessories ordered. Open the shipping cartons and make sure that all of the components indicated on the bill of lading are present.

Reporting shipping problems

Report any problems discovered after you unpack the shipping cartons to both Trimble Customer Support and the shipping carrier.

Installation guidelines

The receiver is designed to be standoff mounted. You must use the appropriate hardware and all of the mounting holes. Otherwise, you violate the receiver hardware warranty. For more information, refer to the drawings of the receiver.

Considering environmental conditions

Install the receiver in a location situated in a dry environment. Avoid exposure to extreme environmental conditions. This includes:

- Water or excessive moisture
- Excessive heat greater than 75 °C (167 °F)
- Excessive cold less than –40 °C (–40 °F)
- Corrosive fluids and gases

Avoiding these conditions improves the receiver’s performance and long-term product reliability.

Supported antennas

The receiver tracks multiple GNSS frequencies; the Trimble Zephyr™ II antenna supports these frequencies.

Other antennas may be used with the receiver. However, ensure that the antenna you choose supports the frequencies you need to track.

For the BD970 receiver, the antenna must operate at 5 V with a greater than 32.5 dB signal at the board antenna port.

Mounting the antennas

Choosing the correct location for the antenna is critical for a high quality installation. Poor or incorrect placement of the antenna can influence accuracy and reliability and may result in damage during normal operation. Follow these guidelines to select the antenna location:

- If the application is mobile, place the antenna on a flat surface along the centerline of the vehicle.
- Choose an area with clear view to the sky above metallic objects.
- ***Avoid*** areas with high vibration, excessive heat, electrical interference, and strong magnetic fields.
- ***Avoid*** mounting the antenna close to stays, electrical cables, metal masts, and other antennas.
- ***Avoid*** mounting the antenna near transmitting antennas, radar arrays, or satellite communication equipment.

Sources of electrical interference

Avoid the following sources of electrical and magnetic noise:

- Gasoline engines (spark plugs)
- Television and computer monitors
- Alternators and generators
- Electric motors
- Propeller shafts
- Equipment with DC-to-AC converters
- Fluorescent lights
- Switching power supplies

Interface board evaluation kit

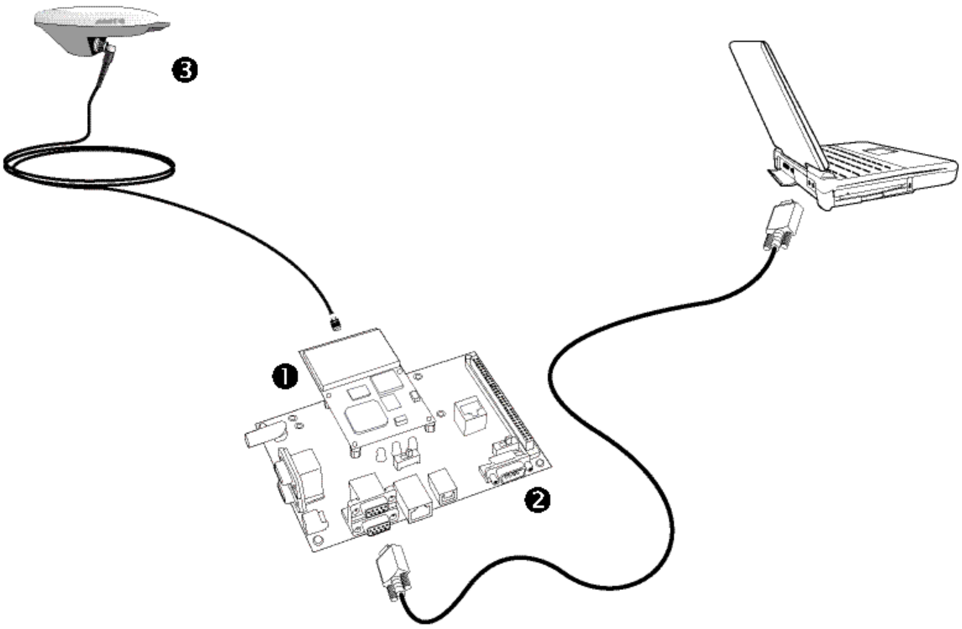
An evaluation kit is available for testing the receiver. It includes an I/O board that gives access to:

- Power input connector
- Power ON/OFF switch
- Three serial ports through DB9 connectors
- Ethernet through an RJ45 connector

  ***Note** – There are separate Ethernet jacks for the BD960/BD982 and BD970 boards.*
- USB port through USB Type B receptacle
- CAN port through a DB9 connector
- Two event input pins
- 1PPS output on BNC connector
- CAN / Serial port 3 switch

  ***Note** – To switch between serial port 3 and CAN, you must configure the receiver using the web interface or binary commands. If you do not set an option bit to make CAN the default, the receiver defaults to serial.*
- Three LEDs to indicate satellite tracking, receipt of corrections, and power

The following figure shows a typical I/O board setup:



❶	BD970 receiver	❷	I/O board	❸	Zephyr antenna

The computer connection provides a means to set up and configure the receiver.

Current or prospective customers may obtain schematic drawings of the evaluation I/O board by contacting GNSSOEMSupport@trimble.com.

Routing and connecting the antenna cable

1. After mounting the antenna, route the antenna cable from the GPS antenna to the receiver.

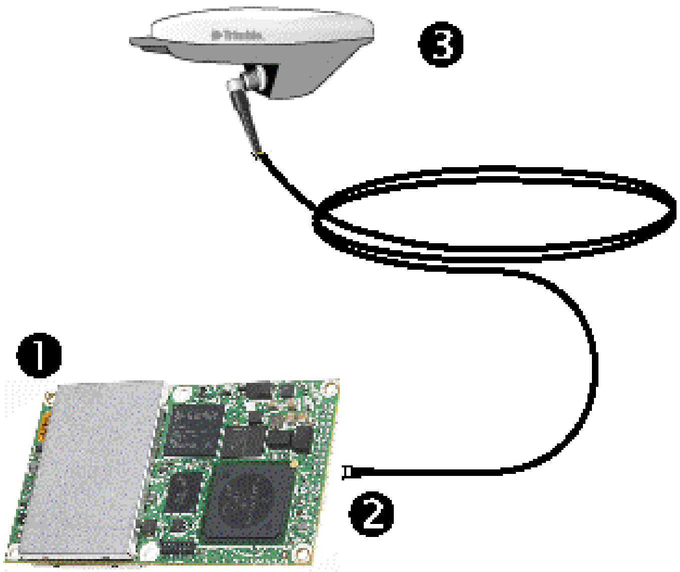
   Avoid the following hazards when routing the antenna cable:

   - Sharp ends or kinks in the cable
   - Hot surfaces (such as exhaust manifolds or stacks)
   - Rotating or reciprocating equipment
   - Sharp or abrasive surfaces
   - Door and window jams
   - Corrosive fluids or gases

2. After routing the cable, connect it to the receiver. Use tie-wraps to secure the cable at several points along the route. For example, to provide strain relief for the antenna cable connection, use a tie-wrap to secure the cable near the base of the antenna.

   ***Note** – When securing the cable, start at the antenna and work towards the receiver.*

3. When the cable is secured, coil any slack. Secure the coil with a tie-wrap and tuck it in a safe place.



❶ BD970 GNSS receiver ❷ MMCX connector ❸ GNSS antenna

***Note** – The MMCX connector at the end of antenna cable needs a CBL ASSY TNC-MMCX connector to interface with the receiver module.*

LED functionality and operation

The evaluation interface board comes with three LEDs to indicate satellite tracking, RTK receptions, and power. The initial boot-up sequence for a receiver lights all the three LEDs for about three seconds followed by a brief duration where all three LEDs are off. Thereafter, use the following table to confirm tracking of satellite signals or for basic troubleshooting.

For single antenna configurations, the following LED patterns apply:

Power LED	RTK Corrections LED	SV Tracking LED	Status
On (continuous)	Off	Off	The receiver is turned on, but not tracking satellites.
On (continuous)	Off	Blinking at 1 Hz	The receiver is tracking satellites, but no incoming RTK corrections are being received.
On (continuous)	Blinking at 1 Hz	Blinking at 1 Hz	The receiver is tracking satellites and receiving incoming RTK corrections.
On (continuous)	Off or blinking (receiving corrections)	Blinking at 5 Hz for a short while	Occurs after a power boot sequence when the receiver is tracking less than 5 satellites and searching for more satellites.
On (continuous)	Blinking at 1 Hz	Off	The receiver is receiving incoming RTK corrections, but not tracking satellites.
On (continuous)	Blinking at 5 Hz	Blinking at 1 Hz	The receiver is receiving Moving Base RTK corrections at 5 Hz.
On (continuous)	On (continuous)	Blinking at 1 Hz	The receiver is receiving Moving Base RTK corrections at 10 or 20 Hz (the RTK LED turns off for 100 ms if a correction is lost).
On (continuous)	On, blinking off briefly at 1 Hz	Blinking at 1 Hz	The receiver is in a base station mode, tracking satellites and transmitting RTK corrections.
On (continuous)	Blinking at 1 Hz	On (continuous)	The receiver is in Boot Monitor Mode. Use the WinFlash utility to reload application firmware onto the board. For more information, contact technical support.

Troubleshooting Receiver Issues

This section describes some possible receiver issues, possible causes, and how to solve them. Please read this section before you contact Technical Support.

Issue	Possible cause	Solution
The receiver does not turn on.	External power is too low.	Check that the input voltage is within limits.
The base station receiver is not broadcasting.	Port settings between reference receiver and radio are incorrect.	Check the settings on the radio and the receiver.
	Faulty cable between receiver and radio.	Try a different cable.
		Examine the ports for missing pins.
		Use a multimeter to check pinouts.
	No power to radio.	If the radio has its own power supply, check the charge and connections.
		Examine the ports for missing pins.
		Use a multimeter to check pinouts.
Rover receiver is not receiving radio.	The base station receiver is not broadcasting.	See the issue "The base station receiver is not broadcasting" above.
	Incorrect over air baud rates between reference and rover.	Connect to the rover receiver radio, and make sure that it has the same setting as the reference receiver.
	Incorrect port settings between roving external radio and receiver.	If the radio is receiving data and the receiver is not getting radio communications, check that the port settings are correct.
The receiver is	The GPS antenna cable is	Make sure that the GPS antenna cable is tightly

Issue	Possible cause	Solution
not receiving satellite signals.	loose.	seated in the GPS antenna connection on the GPS antenna.
	The cable is damaged.	Check the cable for any signs of damage. A damaged cable can inhibit signal detection from the antenna at the receiver.
	The GPS antenna is not in clear line of sight to the sky.	Make sure that the GPS antenna is located with a clear view of the sky.
		Restart the receiver as a last resort (turn off and then turn it on again).

Glossary

1PPS	Pulse-per-second. Used in hardware timing. A pulse is generated in conjunction with a time stamp. This defines the instant when the time stamp is applicable.
almanac	A file that contains orbit information on all the satellites, clock corrections, and atmospheric delay parameters. The almanac is transmitted by a GNSS satellite to a GNSS receiver, where it facilitates rapid acquisition of GNSS signals when you start collecting data, or when you have lost track of satellites and are trying to regain GNSS signals. The orbit information is a subset of the ephemeris/ephemerides data.
base station	Also called *reference station*. In construction, a base station is a receiver placed at a known point on a jobsite that tracks the same satellites as an RTK rover, and provides a real-time differential correction message stream through radio to the rover, to obtain centimeter level positions on a continuous real-time basis. A base station can also be a part of a virtual reference station network, or a location at which GNSS observations are collected over a period of time, for subsequent postprocessing to obtain the most accurate position for the location.
BeiDou	The BeiDou Navigation Satellite System (also known as BDS) is a Chinese satellite navigation system. The first BeiDou system (known as BeiDou-1), consists of four satellites and has limited coverage and applications. It has been offering navigation services mainly for customers in China and from neighboring regions since 2000. The second generation of the system (known as BeiDou-2) consists of satellites in a combination of geostationary, inclined geosynchronous, and medium earth orbit configurations. It became operational with coverage of China in December 2011. However, the complete Interface Control Document (which specifies the satellite messages) was not released until December 2012. BeiDou-2 is a regional navigation service which offers services to customers in the Asia-Pacific region. A third generation of the BeiDou system is planned, which will expand coverage globally. This generation is currently scheduled to be completed by 2020.
BINEX	BInary EXchange format. BINEX is an operational binary format standard for GPS/GLONASS/SBAS research purposes. It is designed to grow and allow encapsulation of all (or most) of the information currently allowed for in a range of other formats.

broadcast server	An Internet server that manages authentication and password control for a network of VRS servers, and relays VRS corrections from the VRS server that you select.
carrier	A radio wave having at least one characteristic (such as frequency, amplitude, or phase) that can be varied from a known reference value by modulation.
carrier frequency	The frequency of the unmodulated fundamental output of a radio transmitter. The GPS L1 carrier frequency is 1575.42 MHz.
carrier phase	Is the cumulative phase count of the GPS or GLONASS carrier signal at a given time.
cellular modems	A wireless adapter that connects a laptop computer to a cellular phone system for data transfer. Cellular modems, which contain their own antennas, plug into a PC Card slot or into the USB port of the computer and are available for a variety of wireless data services such as GPRS.
CMR/CMR+	Compact Measurement Record. A real-time message format developed by Trimble for broadcasting corrections to other Trimble receivers. CMR is a more efficient alternative to RTCM.
CMRx	A real-time message format developed by Trimble for transmitting more satellite corrections resulting from more satellite signals, more constellations, and more satellites. Its compactness means more repeaters can be used on a site.
covariance	A statistical measure of the variance of two random variables that are observed or measured in the same mean time period. This measure is equal to the product of the deviations of corresponding values of the two variables from their respective means.
datum	Also called *geodetic datum*. A mathematical model designed to best fit the geoid, defined by the relationship between an ellipsoid and, a point on the topographic surface, established as the origin of the datum. World geodetic datums are typically defined by the size and shape of an ellipsoid and the relationship between the center of the ellipsoid and the center of the earth. Because the earth is not a perfect ellipsoid, any single datum will provide a better model in some locations than in others. Therefore, various datums have been established to suit particular regions. For example, maps in Europe are often based on the European datum of 1950 (ED-50). Maps in the United States are often based on the North American datum of 1927 (NAD-27) or 1983 (NAD-83). All GPS coordinates are based on the WGS-84 datum surface.
deep discharge	Withdrawal of all electrical energy to the end-point voltage before the

	cell or battery is recharged.
DGPS	See real-time differential GPS.
differential correction	Differential correction is the process of correcting GNSS data collected on a rover with data collected simultaneously at a base station. Because the base station is on a known location, any errors in data collected at the base station can be measured, and the necessary corrections applied to the rover data. Differential correction can be done in real-time, or after the data is collected by postprocessing.
differential GPS	See real-time differential GPS.
DOP	Dilution of Precision. A measure of the quality of GNSS positions, based on the geometry of the satellites used to compute the positions. When satellites are widely spaced relative to each other, the DOP value is lower, and position precision is greater. When satellites are close together in the sky, the DOP is higher and GNSS positions may contain a greater level of error. PDOP (Position DOP) indicates the three-dimensional geometry of the satellites. Other DOP values include HDOP(Horizontal DOP) and VDOP (Vertical DOP), which indicate the precision of horizontal measurements (latitude and longitude) and vertical measurements respectively. PDOP is related to HDOP and VDOP as follows: $PDOP^2 = HDOP^2 + VDOP^2$.
dual-frequency GPS	A type of receiver that uses both L1 and L2 signals from GPS satellites. A dual-frequency receiver can compute more precise position fixes over longer distances and under more adverse conditions because it compensates for ionospheric delays.
EGNOS	European Geostationary Navigation Overlay Service. A Satellite-Based Augmentation System (SBAS) that provides a free-to-air differential correction service for GNSS. EGNOS is the European equivalent of WAAS, which is available in the United States.
elevation	The vertical distance from a geoid such as EGM96 to the antenna phase center. The geoid is sometimes referred to as Mean Sea Level.
elevation mask	The angle below which the receiver will not track satellites. Normally set to 10 degrees to avoid interference problems caused by buildings and trees, atmospheric issues, and multipath errors.
ellipsoid	An ellipsoid is the three-dimensional shape that is used as the basis for mathematically modeling the earth’s surface. The ellipsoid is defined by the lengths of the minor and major axes. The earth’s minor axis is the polar axis and the major axis is the equatorial axis.

EHT	Height above ellipsoid.
ephemeris/ephemerides	A list of predicted (accurate) positions or locations of satellites as a function of time. A set of numerical parameters that can be used to determine a satellite's position. Available as broadcast ephemeris or as postprocessed precise ephemeris.
epoch	The measurement interval of a GNSS receiver. The epoch varies according to the measurement type: for real-time measurement it is set at one second; for postprocessed measurement it can be set to a rate of between one second and one minute. For example, if data is measured every 15 seconds, loading data using 30-second epochs means loading every alternate measurement.
feature	A feature is a physical object or event that has a location in the real world, which you want to collect position and/or descriptive information (attributes) about. Features can be classified as surface or non-surface features, and again as points, lines/break lines, or boundaries/areas.
firmware	The program inside the receiver that controls receiver operations and hardware.
GAGAN	GPS Aided Geo Augmented Navigation. A regional SBAS system currently in development by the Indian government.
Galileo	Galileo is a GNSS system built by the European Union and the European Space Agency. It is complimentary to GPS and GLONASS.
geoid	The geoid is the equipotential surface that would coincide with the mean ocean surface of the Earth. For a small site this can be approximated as an inclined plane above the Ellipsoid.
GHT	Height above geoid.
GIOVE	Galileo In-Orbit Validation Element. The name of each satellite for the European Space Agency to test the Galileo positioning system.
GLONASS	Global Orbiting Navigation Satellite System. GLONASS is a Soviet space-based navigation system comparable to the American GPS system. The operational system consists of 21 operational and 3 non-operational satellites in 3 orbit planes.
GNSS	Global Navigation Satellite System.
GPS	Global Positioning System. GPS is a space-based satellite navigation system consisting of multiple satellites in six orbit planes.
GSOF	General Serial Output Format. A Trimble proprietary message format.
HDOP	Horizontal Dilution of Precision. HDOP is a DOP value that indicates the

	precision of horizontal measurements. Other DOP values include VDOP (vertical DOP) and PDOP (Position DOP). Using a maximum HDOP is ideal for situations where vertical precision is not particularly important, and your position yield would be decreased by the vertical component of the PDOP (for example, if you are collecting data under canopy).
height	The vertical distance above the Ellipsoid. The classic Ellipsoid used in GPS is WGS-84.
IBSS	Internet Base Station Service. This Trimble service makes the setup of an Internet-capable receiver as simple as possible. The base station can be connected to the Internet (cable or wirelessly). To access the distribution server, the user enters a password into the receiver. To use the server, the user must have a Trimble Connected Community site license.
L1	The primary L-band carrier used by GPS and GLONASS satellites to transmit satellite data.
L2	The secondary L-band carrier used by GPS and GLONASS satellites to transmit satellite data.
L2C	A modernized code that allows significantly better ability to track the L2 frequency.
L5	The third L-band carrier used by GPS satellites to transmit satellite data. L5 will provide a higher power level than the other carriers. As a result, acquiring and tracking weak signals will be easier.
Location RTK	Some applications such as vehicular-mounted site supervisor systems do not require Precision RTK accuracy. Location RTK is a mode in which, once initialized, the receiver will operate either in 10 cm horizontal and 10 cm vertical accuracy, or in 10 cm horizontal and 2 cm vertical accuracy.
Mountpoint	Every single NTripSource needs a unique mountpoint on an NTripCaster. Before transmitting GNSS data to the NTripCaster, the NTripServer sends an assignment of the mountpoint.
Moving Base	Moving Base is an RTK positioning technique in which both reference and rover receivers are mobile. Corrections are sent from a “base” receiver to a “rover” receiver and the resultant baseline (vector) has centimeter-level accuracy.
MSAS	MTSAT Satellite-Based Augmentation System. A Satellite-Based Augmentation System (SBAS) that provides a free-to-air differential correction service for GNSS. MSAS is the Japanese equivalent of WAAS, which is available in the United States.

multipath	Interference, similar to ghosts on an analog television screen that occurs when GNSS signals arrive at an antenna having traversed different paths. The signal traversing the longer path yields a larger pseudorange estimate and increases the error. Multiple paths can arise from reflections off the ground or off structures near the antenna.
NMEA	National Marine Electronics Association. NMEA 0183 defines the standard for interfacing marine electronic navigational devices. This standard defines a number of 'strings' referred to as NMEA strings that contain navigational details such as positions. Most Trimble GNSS receivers can output positions as NMEA strings.
NTrip Protocol	Networked Transport of RTCM via Internet Protocol (NTrip) is an application-level protocol that supports streaming Global Navigation Satellite System (GNSS) data over the Internet. NTrip is a generic, stateless protocol based on the Hypertext Transfer Protocol (HTTP). The HTTP objects are extended to GNSS data streams.
NTripCaster	The NTripCaster is basically an HTTP server supporting a subset of HTTP request/response messages and adjusted to low-bandwidth streaming data. The NTripCaster accepts request messages on a single port from either the NTripServer or the NTripClient. Depending on these messages, the NTripCaster decides whether there is streaming data to receive or to send. Trimble NTripCaster integrates the NTripServer and the NTripCaster. This port is used only to accept requests from NTripClients.
NTripClient	An NTripClient will be accepted by and receive data from an NTripCaster, if the NTripClient sends the correct request message (TCP/UDP connection to the specified NTripCaster IP and listening port).
NTripServer	The NTripServer is used to transfer GNSS data of an NTripSource to the NTripCaster. An NTripServer in its simplest setup is a computer program running on a PC that sends correction data of an NTripSource (for example, as received through the serial communication port from a GNSS receiver) to the NTripCaster. The NTripServer - NTripCaster communication extends HTTP by additional message formats and status codes.
NTripSource	The NTripSources provide continuous GNSS data (for example, RTCM-104 corrections) as streaming data. A single source represents GNSS data referring to a specific location. Source description parameters are compiled in the source-table.
OmniSTAR	The OmniSTAR HP/XP service allows the use of new generation dual-frequency receivers with the OmniSTAR service. The HP/XP service

	does not rely on local reference stations for its signal, but utilizes a global satellite monitoring network. Additionally, while most current dual-frequency GNSS systems are accurate to within a meter or so, OmniSTAR with XP is accurate in 3D to better than 30 cm.
Orthometric elevation	The Orthometric Elevation is the height above the geoid (often termed the height above the 'Mean Sea Level').
PDOP	Position Dilution of Precision. PDOP is a DOP value that indicates the precision of three-dimensional measurements. Other DOP values include VDOP (vertical DOP) and HDOP (Horizontal Dilution of Precision). Using a maximum PDOP value is ideal for situations where both vertical and horizontal precision are important.
postprocessing	Postprocessing is the processing of satellite data after it is collected, in order to eliminate error. This involves using computer software to compare data from the rover with data collected at the base station.
QZSS	Quasi-Zenith Satellite System. A Japanese regional GNSS, eventually consisting of three geosynchronous satellites over Japan.
real-time differential GPS	Also known as *real-time differential correction* or *DGPS*. Real-time differential GPS is the process of correcting GPS data as you collect it. Corrections are calculated at a base station and then sent to the receiver through a radio link. As the rover receives the position it applies the corrections to give you a very accurate position in the field. Most real-time differential correction methods apply corrections to code phase positions. While DGPS is a generic term, its common interpretation is that it entails the use of single-frequency code phase data sent from a GNSS base station to a rover GNSS receiver to provide submeter position accuracy. The rover receiver can be at a long range (greater than 100 kms (62 miles)) from the base station.
rover	A rover is any mobile GNSS receiver that is used to collect or update data in the field, typically at an unknown location.
Roving mode	Roving mode applies to the use of a rover receiver to collect data, stakeout, or control machinery in real time using RTK techniques.
RTCM	Radio Technical Commission for Maritime Services. A commission established to define a differential data link for the real-time differential correction of roving GNSS receivers. There are three versions of RTCM correction messages. All Trimble GNSS receivers use Version 2 protocol for single-frequency DGPS type corrections. Carrier phase corrections are available on Version 2, or on the newer Version 3 RTCM protocol, which is available on certain Trimble dual-frequency receivers. The

	Version 3 RTCM protocol is more compact but is not as widely supported as Version 2.
RTK	Real-time kinematic. A real-time differential GPS method that uses carrier phase measurements for greater accuracy.
SBAS	Satellite-Based Augmentation System. SBAS is based on differential GPS, but applies to wide area (WAAS/EGNOS/MSAS) networks of reference stations. Corrections and additional information are broadcast using geostationary satellites.
sCMRx	Scrambled CMRx. CMRx is a new Trimble message format that offers much higher data compression than Trimble's CMR/CMR+ formats.
signal-to-noise ratio	SNR. The signal strength of a satellite is a measure of the information content of the signal, relative to the signal's noise. The typical SNR of a satellite at 30° elevation is between 47 and 50 dB-Hz.
skyplot	The satellite skyplot confirms reception of a differentially corrected GNSS signal and displays the number of satellites tracked by the GNSS receiver, as well as their relative positions.
SNR	See signal-to-noise ratio.
Source-table	The NTripCaster maintains a source-table containing information on available NTripSources, networks of NTripSources, and NTripCasters, to be sent to an NTripClient on request. Source-table records are dedicated to one of the following: • data STReams (record type STR) • CASters (record type CAS) • NETworks of data streams (record type NET) All NTripClients must be able to decode record type STR. Decoding types CAS and NET is an optional feature. All data fields in the source-table records are separated using the semicolon character.
triple frequency GPS	A type of receiver that uses three carrier phase measurements (L1, L2, and L5).
UTC	Universal Time Coordinated. A time standard based on local solar mean time at the Greenwich meridian.
xFill	Trimble xFill™ is a new service that extends RTK positioning for several minutes when the RTK correction stream is temporarily unavailable. The Trimble xFill service improves field productivity by reducing downtime waiting to re-establish RTK corrections in black spots. It can even expand productivity by allowing short excursions into valleys and other locations where continuous correction messages were not

	previously possible. Proprietary Trimble xFill corrections are broadcast by satellite and are generally available on construction sites globally where the GNSS constellations are also visible. It applies to any positioning task being performed with a single-base, Trimble Internet Base Station Service (IBSS), or VRS™ RTK correction source.
variance	A statistical measure used to describe the spread of a variable in the mean time period. This measure is equal to the square of the deviation of a corresponding measured variable from its mean. See also covariance.
VDOP	Vertical Dilution of Precision. VDOP is a DOP value (dimensionless number) that indicates the quality of GNSS observations in the vertical frame.
VRS	Virtual Reference Station. A VRS system consists of GNSS hardware, software, and communication links. It uses data from a network of base stations to provide corrections to each rover that are more accurate than corrections from a single base station. To start using VRS corrections, the rover sends its position to the VRS server. The VRS server uses the base station data to model systematic errors (such as ionospheric noise) at the rover position. It then sends RTCM correction messages back to the rover.
WAAS	Wide Area Augmentation System. WAAS was established by the Federal Aviation Administration (FAA) for flight and approach navigation for civil aviation. WAAS improves the accuracy and availability of the basic GNSS signals over its coverage area, which includes the continental United States and outlying parts of Canada and Mexico. The WAAS system provides correction data for visible satellites. Corrections are computed from ground station observations and then uploaded to two geostationary satellites. This data is then broadcast on the L1 frequency, and is tracked using a channel on the GNSS receiver, exactly like a GNSS satellite. Use WAAS when other correction sources are unavailable, to obtain greater accuracy than autonomous positions. For more information on WAAS, refer to the FAA website at http://gps.faa.gov. The EGNOS service is the European equivalent and MSAS is the Japanese equivalent of WAAS.
WGS-84	World Geodetic System 1984. Since January 1987, WGS-84 has superseded WGS-72 as the datum used by GPS. The WGS-84 datum is based on the ellipsoid of the same name.